



Province of British Columbia

**RAVENS
AND THEIR EFFECT ON SHEEP PRODUCTION
ON SALTSPRING ISLAND, BRITISH COLUMBIA:**

A PRELIMINARY STUDY

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PREFACE

This study was carried out from January to May 1985 under contract to the Crop Protection Branch, B.C. Ministry of Agriculture and Food.

Dr. Anne Branchley, an ornithologist and ecologist, was born and educated in the United Kingdom. She earned her B.Sc. (Honours Zoology) and Ph.D. degrees at the University of Aberdeen, where her doctoral research dealt with the ecology of the Rook (Corvus frugilegus) in relation to agricultural land use. During the course of this study, she resided at Nanaimo, B.C.

Opinions expressed and recommendations given in this report are those of the author and not necessarily those of the Ministry of Agriculture and Food.

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TABLE OF CONTENTS

	Page
Preface	i
List of Tables	iii
List of Figures	iii
List of Appendices	iv
Abstract	v
Acknowledgments	vi
Introduction	1
Lambing Season and Raven Attacks	1
Raven Trapping	3
Abundance and Distribution of Ravens	5
Nesting Biology	9
Concluding Discussion	10
Recommendations	13
References	15

LIST OF TABLES

Table		Page
1	Attacks on Lambs and Ewes - Saltspring Island, 1985	2
2	Raven Banding Data - Saltspring Island, 1985	4
3	Summary of Raven and Crow Surveys - Saltspring Island, 1985	7
4	Ravens Recorded on Roadside Breeding Bird Surveys - Vancouver Island, 1976-1983	8

LIST OF FIGURES

Figure		Page
1	Location of Stopping Points on Roadside Survey - Saltspring Island, 1985	6
2	Locations of Pairs of Ravens Holding Territories - Saltspring Island, 1985	11

LIST OF APPENDICES

Appendix		Page
1	Raven Attack Reporting Form	16
2	Raven Trapping Information - Saltspring Island, 1985	17
3	Raven Survey - January 31, 1985	18
4	Raven Survey - February 22, 1985	19
5	Raven Survey - March 14, 1985	20
6	Raven Survey - April 5, 1985	21
7	Raven Survey - April 24-25, 1985	22
8	Raven Survey - May 16, 1985	23
9	Distribution of Ravens and Crows on Roadside Surveys 1-6	24
10	Habitat Composition Within 1/4 Mile Radius of Each Stop	25
11	Raven Counts - Blackburn Road Garbage Dump, 1985	26
12	Details of Three Known Nest Sites - Saltspring Island, 1985	27

ABSTRACT

Raven biology and predation on sheep were studied on Saltspring Island, B.C. between January and May 1985. At least 28 lambs (about 1% of those born) and three adult ewes were killed by ravens, apparently a lower than average rate of loss. Numbers of ravens were monitored by regular roadside counts and regular counts at the Blackburn Road garbage dump. The island population was estimated at roughly 300 ravens, being somewhat higher in winter. Between 20 and 120 ravens were regularly present at the dump, and probably consisted mainly of immatures and non-breeding adults. At least 31 pairs of ravens were believed to have bred on Saltspring Island, resulting in a higher breeding density (26 pairs per 100 km²) than any reported elsewhere. Three active nests were found; all were located in concealed positions, high in trees in dense conifer forest. Cliff nests have also been reported on the island. Eleven ravens were trapped, marked with plastic wing-tags and released, but this number of tagged birds was insufficient to yield much information on movements.

It is concluded that the severity of the depredation problem resulted largely from the extremely high density of ravens, and a number of recommendations for alleviation of the problem are made.

ACKNOWLEDGMENTS

This short study would have been far more difficult if not for the co-operation of many of the Saltspring Island sheep producers. In particular, Mike Byron helped with trapping ravens on Stark Road, regularly feeding the captive ravens and checking whether additional birds had been caught. Gwen Ruckle, Brodie Cupples, Ray Stewart and Howard Byron provided much local knowledge and information concerning sheep husbandry and raven sightings. Local naturalists, including Alan and Raymond Best, Chris Wooldridge, Marguerite Pearce, Bristol Foster and Allison McKerrow, helped to locate nests, observe birds and provide general information on ravens.

Thanks go also to Dr. Wayne Weber who spent several days helping with raven surveys and other work concerned with this project; Tony Kluge, who helped in marking and releasing the captured ravens; Dr. Steve Mason and Peter Fofonoff, who shared their knowledge of local agriculture and animal husbandry; Bill Munro, who obtained a colour-marking permit for us and supplied the aluminum leg-bands; and Wayne Campbell, who made comparative data from the Roadside Breeding Bird Survey available.

Introduction

The problem of Common Raven (Corvus corax) depredation on newborn lambs has been a contentious issue on Saltspring Island for over ten years. As a result of information received from questionnaires sent out to a sample of Saltspring Island sheep producers since 1982, it was estimated that up to 100 lambs were killed by ravens each year. Attacks appeared to occur throughout the island, with different farmers suffering losses each year.

This project was designed to:

1. determine the abundance and distribution of ravens on the island by regular counts at the Blackburn Road garbage dump and roadside surveys elsewhere on the island;
2. gain accurate information on the number and type of attacks on sheep during the 1985 lambing season;
3. attempt to locate two or three raven nests and record information on breeding biology and diet;
4. catch and mark a number of ravens so that movements on Saltspring Island and possibly to and from the other Gulf Islands and Vancouver Island could be studied; and
5. make recommendations to alleviate the raven depredation problem.

Lambing Season and Raven Attacks

In 1985, lambing took place mainly from January through March, with the peak in mid-February. Reports of attacks on sheep were received from Howard Byron (Dog Control Officer) and Ray Stewart (Farmers' Institute). These were followed by visits to the sheep producers concerned and details of each attack were recorded on a special form (Appendix 1).

Most lamb mortality occurred from the last week of January through the middle of February (Table 1). Thirty-one sheep (three ewes and 28 lambs) were reported to be killed by ravens. This is probably a minimum number as it is likely that other unrecorded losses occurred. One sheep producer, Mike Byron, had four ewes that lambed but the lambs were never found. Newborn lambs may have been killed by ravens and subsequently removed by other scavengers such as Bald Eagles (Haliaeetus leucocephalus). Sheep producers who have free-ranging animals may lose some lambs without ever knowing the exact cause.

Raven attacks occurred throughout the north and central parts of the island. Two of the sheep producers with the greatest losses, Mervin Walde (7) and Jack Webster (7), were located in the central area in close proximity to the Blackburn Road garbage dump, where large numbers of ravens were constantly seen.

Table 1. Attacks on Lambs and Ewes - Saltspring Island, 1985

Date	Name of Sheep Producer	Location	No. Sheep Attacked (Killed)
Jan 21	M. Byron	Stark Road	3 (2)
Jan 28	B. Hughes	Vesuvius Road	1 (1)
Jan 31	T. Luton	Fulford-Ganges Road	1 (1)
Jan 31	L. Harkema	Fernwood Road	1 (1)
Feb 03	H. Byron	Beddis Road	1 (1)
Feb 04	M. Byron	Stark Road	2 (2)
Feb 06	L. Harkema	Fernwood Road	1 (1)
Feb 09	M. Byron	Stark Road	1 (1)
late Jan - mid-Feb	M. Walde	Fulford-Ganges Road	9 (7)
mid-Feb	M. Robley	Stark Road	2 (2)
mid-Feb	M. Robley	Sunset Drive	1 (1)
mid-Feb	J. Webster	Blackburn Road	6 (6)
Feb 17	M. Byron	Stark Road	many*
Feb 28	J. Webster	Blackburn Road	1 (1)
Mar 02	M. Byron	Stark Road	1 (1)
Mar 12	M. Byron	Stark Road	1 -
Apr 13	G. Ruckle	Beaver Pt./Ruckle Pk.	1 (1) ewe
Apr 14	R. Lazuruk	Stark Road	1 (1) ewe
May 13	R. Lazuruk	Stark Road	<u>1 (1)</u> ewe

Total: 35(31)

*Ears and tails pecked during snow cover

Lambs were evidently killed by pecks to the eyes, top of head, mouth (especially tongue) and anal area. Post-mortem examination can determine exactly when and how each animal died (McFarlane, 1965) but such examinations were not possible during this study. However, external examination of the wounds can show whether the animal was alive before attack or was a scavenged carcass. Attacks made on a lamb while it is still alive can be clearly identified by haemorrhages around the wound site and there is usually considerable bleeding from the wound, whereas attacks made after death show no hemorrhages and little bleeding (Houston, 1977). On Saltspring Island, some of the lambs that survived raven attacks had to be destroyed. The first lamb of twins appeared to be the more vulnerable because the ewe was unable to defend her first offspring while giving birth to the second. Lambs more than three days old were rarely attacked unless sick. The three ewes that were killed later in the season all had their eyes pecked out while unable to get up after falling over.

Questionnaire results indicated that approximately 2000 breeding ewes were present on Saltspring Island in 1985 and that a maximum of 3000 lambs would be born. The loss of 28 lambs by raven predation was about 1% of the expected lamb crop, which was smaller than that reported in previous years. It is likely that a higher percentage of lambs was lost to other causes such as hypothermia, disease and dog predation.

Raven Trapping

A modified Australian crow trap, similar to that described by Kluge and Weber (1984), was used to capture ravens during the period of this study. Four captive ravens were used as decoys in the trap set up in Mike Byron's field on Stark Road. A total of 11 wild ravens were caught between January 31 and February 14 (Appendix 2). These ravens were banded, marked with white plastic wing tags (see Stiehl, 1983) bearing individual alpha-numeric codes and released (Table 2). Unfortunately on February 18, an animal (probably a raccoon) entered the trap and the captive birds subsequently escaped. Trapping was discontinued as no more captive ravens were immediately available.

It had been hoped that at least 25 tagged ravens would be released on Saltspring Island so that their movements could be observed. Four of the 11 ravens captured were released on Vancouver Island and were not seen again. There were several reports of the seven remaining ravens at Ruckle Provincial Park, Blackburn Road garbage dump, the vicinity of capture on Stark Road and at the Cupples farm on North End Road. However, without the aid of a spotting scope, the individual identification of these tagged birds was almost impossible. Two birds, A3 and A4, were identified by me; A3 was regularly seen at the garbage dump and A4 was identified once at the Cupples farm on March 5, where a group of up to 20 ravens was seen feeding in a grass field recently spread with manure. However, these observations were insufficient to give any general idea of raven movements on Saltspring Island.

Table 2. Raven Banding Data - Saltspring Island, 1985

Date	Band No.	Tag No.	Approx. Age	Release Site
Jan 21	1007-676609	-	?	into trap
Jan 21	1007-676610	-	?	into trap
Jan 21	1007-676611	-	?	into trap
Jan 21	1007-676612	-	?	into trap
Feb 1	1007-676613	A1*	juvenile	Stark Road, Saltspring Is.
Feb 1	1007-676614	A2	juvenile	Stark Road, Saltspring Is.
Feb 1	1007-676615	A3	juvenile	Stark Road, Saltspring Is.
Feb 1	1007-676616	A4	adult	Stark Road, Saltspring Is.
Feb 1	1007-676617	A5	adult	Beacon Hill Park, Victoria
Feb 1	1007-676618	A6	subadult	Piper's Lagoon, Nanaimo
Feb 1	1007-676619	A7	subadult	Beacon Hill Park, Victoria
Feb 1	1007-676620	A8	adult	Piper's Lagoon, Nanaimo
Feb 14	-	B1	adult	Ruckle Park, Saltspring Is.
Feb 14	-	B2	adult	Ruckle Park, Saltspring Is.
Feb 14	-	B3	subadult	Ruckle Park, Saltspring Is.

* alpha-numeric code: letter designates date, number indicates order of banding

Abundance and Distribution of Ravens

According to several people who have lived on Saltspring Island for most of their lives, ravens were not recorded on the island until the mid 1940s. They were seen infrequently until the late 1960s when the numbers began to build up. Data from the Provincial Museum in Victoria indicate that a similar population increase occurred over most of coastal British Columbia. Until the late 1960s, records of over ten ravens at one place at one time were rare, with the exception of some counts at the Comox garbage dump by Theed Pearse (Pearse 1938). From the 1960s onward, records of groups of ravens became regular.

To determine the abundance and distribution of ravens on Saltspring Island, six roadside surveys were conducted at three-week intervals. A route that covered most of the major roads on the island was chosen. Stops were made at each mile along this route and the numbers of ravens and Northwestern Crows (*Corvus caurinus*) seen or heard in a three minute period were recorded. This method followed that of the North American Roadside Breeding Bird Survey (Robbins and Van Velzen, 1967) except that the intervals between stops were one mile instead of half a mile. A total of 51 stops were used (Figure 1), one of these being the Blackburn Road garbage dump (stop 41). Eighty to 100 ravens were recorded on each survey except the last, with the number of crows always exceeding that of the ravens (Table 3a, Appendices 3-8). The number of ravens was fairly stable from January to the end of April and then decreased in May. The number of crows decreased over the study period. The majority of crows was observed at the garbage dump until the May count, when their distribution was more uniform throughout the island.

The average number of ravens per stop recorded on the survey route, excluding those at the garbage dump, decreased from 1.38 in January to 0.52 in May, whereas the number of crows remained more stable (Table 3b). Ravens were recorded at least once at 45 of the 51 stops, with the largest numbers seen at one time around the Cupples farm, Mt. Belcher, Mt. Bruce, Mt. Maxwell and the garbage dump. Three of the stopping points (15, 16 and 31) with no ravens included a large proportion of salt water within 1/4 mile. The distribution of crows was mainly concentrated at the coastal stopping points with large numbers always seen at Long Harbour, Ganges, Fulford Harbour, northwest of Vesuvius and at Cusheon Lake (Appendix 9). Although a simple habitat distribution survey, similar to that of Weber and Theberge (1977), was conducted on May 9 and 10 (Appendix 10), no obvious relationship between raven distribution and habitat was found.

The average number of ravens per stop was compared to that of the Roadside Breeding Bird Surveys conducted at several locations on Vancouver Island over the past nine years (data provided by the Vertebrate Zoology Section, Provincial Museum, Victoria). It was shown that the number of ravens recorded on Saltspring Island was always considerably higher than elsewhere (Table 4).

Figure 1. Location of Stopping Points on Roadside Survey - Saltspring Island, 1985



Table 3. Summary of Raven and Crow Surveys - Saltspring Island, 1985

- a. Total numbers of ravens and crows recorded, including counts from Blackburn Road garbage dump

Date	No. Ravens Seen	No. Ravens Heard	Total No. Ravens	No. Crows Recorded
Jan 31	44	46	90	257
Feb 22	47	34	81	642+
Mar 14	54	42	96	178
Apr 05	37	43	80	257
Apr 24/25	53	34	87	126
May 16	34	22	56	88

- b. Details of raven and crow distribution from six surveys, excluding counts from Blackburn Road garbage dump

Date	Total No. Ravens	No. Stops Ravens Recorded	Avg. No. Ravens/ Stop*	Total No. Crows	No. Stops Crows Recorded	Avg. No Crows/ Stop**
Jan 31	69	24	1.38	57	8	1.14
Feb 22	50	23	1.00	72	9	1.44
Mar 14	75	25	1.50	108	19	2.16
Apr 05	59	25	1.18	92	22	1.84
Apr 24/25	36	20	0.72	76	18	1.52
May 16	26	11	0.52	73	20	1.46

* total number of ravens recorded divided by 50 stops

** total number of crows recorded divided by 50 stops

Table 4.

Ravens Recorded on Roadside Breeding Bird Surveys - Vancouver Island, 1976-1983

Location	Year*	Total No. Ravens	No. Stops Ravens Recorded	Avg. No. Ravens/ Stop **
Campbell River	1976	15	13	0.30
	1978	8	6	0.16
	1981	9	5	0.18
	1982	8	6	0.16
Nanaimo	1976	17	10	0.34
	1978	8	7	0.16
	1981	8	8	0.16
	1982	8	8	0.16
	1983	12	8	0.24
Chemainus	1976	4	2	0.08
	1978	3	3	0.06
Victoria	1976	6	5	0.12
	1978	3	3	0.06
	1981	2	2	0.04
	1982	11	6	0.22

* surveys conducted in June of each year

**total number of ravens recorded divided by 50 stops

Where possible, daily counts of ravens were made at the Blackburn Road garbage dump. It was originally intended that the time of day at which the counts were made should be varied. In this way, daily fluctuations in number might be determined. However, vehicles entered the dump at 5 to 10 minute intervals from 10:00 to 16:30 each day so that the birds were constantly disturbed and counts became difficult. Early morning counts were therefore most useful, but these became less regular as the breeding season progressed as this time of day was also best for observing breeding activity.

More than 20 ravens were always seen at the garbage dump with no notable increase or decrease in numbers over the study period (Appendix 11). Most ravens spent their time either circling around in the air, spotting and harassing crows with food, or resting in the surrounding conifers in the middle of the day. Ravens were seen feeding on the ground in large numbers only in the early morning. It is likely that most of the ravens at the dump were either first-year birds that had not yet come into breeding condition or non-breeding adults. For example, A3, a tagged bird regularly seen at the dump, was a subadult. Members of the breeding population may have visited the dump periodically when natural food sources were scarce or unavailable.

The number of crows observed feeding at the dump peaked in January and February when 500 birds were seen on most days. This number declined to 50 to 100 in April and May, and it would appear that the winter population moves off the island when the breeding season begins. The crows were only minimally disturbed by regular vehicle activity at the dump and were always the first to return after such disturbance.

The raven count data collected from the roadside surveys, the garbage dump counts and pairs on territory suggest that the total population of ravens on Saltspring probably exceeds 300 birds in winter, dropping to just below this number when the breeding season begins. However, once the breeding adults scatter to form pairs on territory, it becomes more difficult to give a population estimate.

Nesting Biology

Ravens usually begin nest-building in late February to early March and lay 3 to 7 eggs which are incubated for 21 days (Holyoak, 1967; Goodwin, 1976; Stiehl, 1985). The period from hatching to fledging is 40 to 45 days (Stiehl, 1985).

Nests can be located in trees (mostly conifers), cliff ledges and occasionally buildings. Despite making contact with several local naturalists, no exact locations of raven nests were obtained for Saltspring prior to the breeding season. This lack of specific knowledge meant that finding nest sites became very time-consuming because an abundance of suitable nest sites appeared to be available.

Spring was slightly later than average this year, judging by the first appearance of many spring flowers and the beginning of breeding activity for many common birds. The earliest signs of ravens nest-building was on March 14, although pairs had been seen on territory prior to this. By April 10, three nest sites had been located (Figure 2, Appendix 12). No more active nests were found after that date. Later in April, three other nests that had been in use in previous years were shown to me: one on Stark Road and two on the Patterson property south of the Fulford Harbour ferry terminal. All of these nests were in trees, four in Douglas-firs (Pseudotsuga menziesii), one in a grand fir (Abies grandis) and one in broadleaf maple (Acer macrophyllum). These sites occupied average-sized trees, often in small valleys, which could be easily observed from the tops of surrounding trees but which a human observer could only see from directly below. Two other nest sites on cliff ledges on Mount Belcher were reported by Alan Best to have been in use in 1983, but these were not readily accessible so they were not investigated.

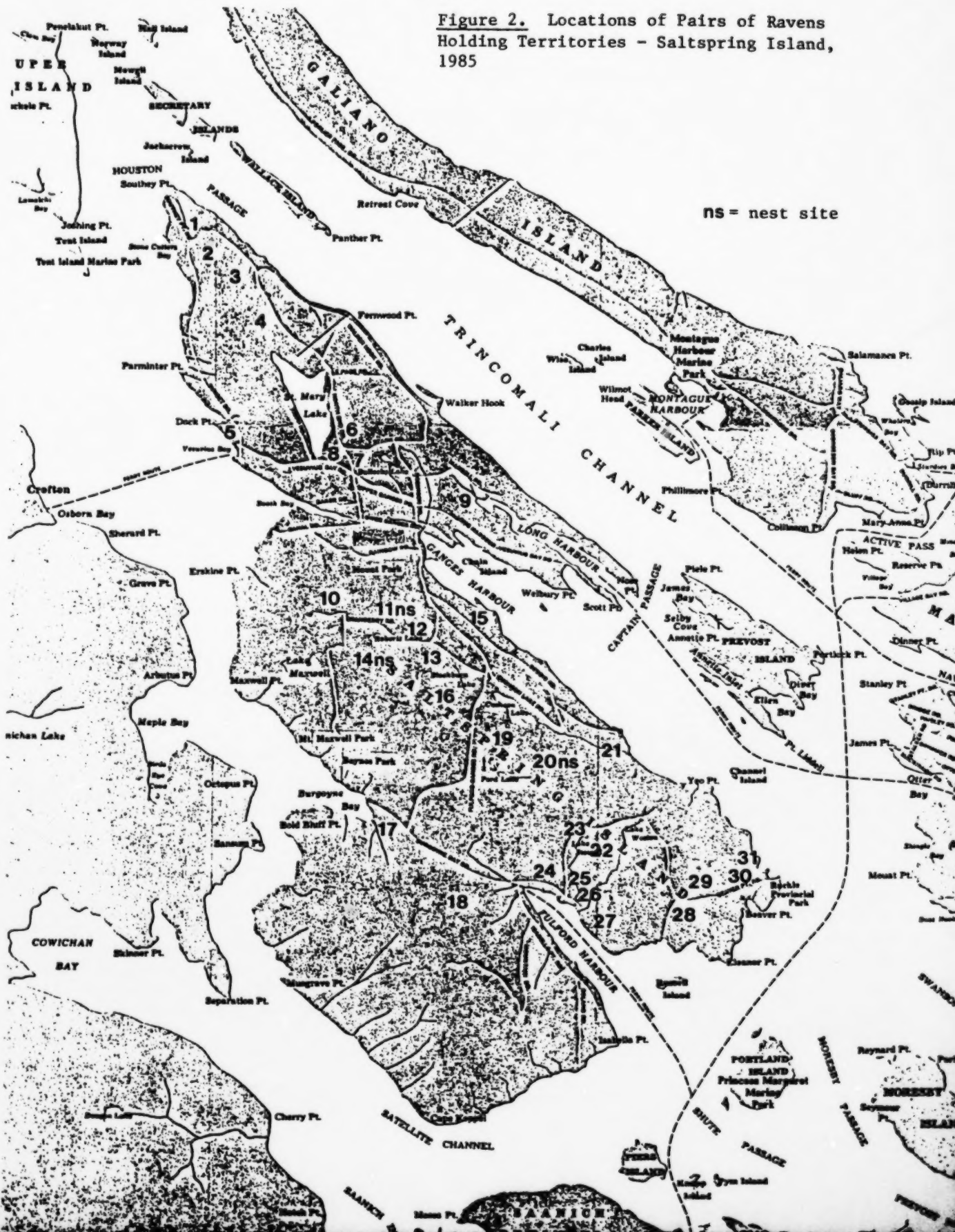
Of the three occupied nests observed in 1985, two were abandoned before hatching while the third produced two or three young which fledged about June 20 (Appendix 12). The reasons for nest abandonment were unknown but one nest (Mt. Belcher) was extremely close to the Blackburn Road garbage dump and other ravens regularly invaded the pair's territory. Interference or nest predation may have taken place.

Altogether, 31 raven territories were located on the island, excluding the area of Mt. Bruce, Mt. Tuam and Mt. Sullivan (Figure 2). This produced a minimum density of 26 nests/100 km². When compared to the highest recorded density in Europe, of 17 nests/100 km² in mid-Wales (Newton et al., 1982), where the habitat type is very similar to that of coastal British Columbia, the breeding density of ravens on Saltspring is very high.

Concluding Discussion

As no studies have been done on the ecology of the raven in western British Columbia, the reasons for the recent increase in raven abundance can only be surmised. The fact that ravens are consistently observed at landfill garbage dumps and that the growth of human populations has increased the need for these dumps is probably no coincidence. Other corvid species, such as the Black-billed Magpie (Pica pica), American Crow (Corvus brachyrhynchos) and Northwestern Crow, have been shown to readily adapt to urban environments. In its more traditional wilderness environment, the raven is a natural scavenger and, along with birds of prey, helps to clean up bird and mammal carcasses. It is only a small step to take advantage of livestock farming and garbage dumps. The adult raven has no natural predators except man; it outcompetes other corvids and is extremely aggressive towards birds of prey, such as the Bald Eagle, Turkey Vulture (Cathartes aura) and the Red-tailed Hawk (Buteo jamaicensis), during the breeding season when these may be perceived as a threat to eggs and young.

Figure 2. Locations of Pairs of Ravens Holding Territories - Saltspring Island, 1985



It is apparent, from this study, that the raven population on Saltspring Island is high in comparison to other nearby localities on Vancouver Island. The reasons for this high population density are probably related to food supply.

The numbers of sheep on Saltspring Island have apparently remained stable for several decades, whereas the husbandry practices in many instances have markedly improved. Many of the small-scale farmers (with up to 50 breeding ewes), whose main income does not come from sheep, now have barns or some kind of shelter for lambing. In these cases, the lambs are protected for the first few days and attacks by ravens occur rarely and only when the lambs are free to roam outdoors. Crows regularly enter buildings to take animal feed but ravens are not known to do this. Therefore, it is unlikely that sheep farming has been responsible for an increase in raven numbers.

It is more probable that the landfill garbage dump, which has been operational for approximately 20 years, attracted ravens to Saltspring Island. The capacity of the dump has enlarged with the increase in population of the island, currently estimated to be about 6000. Many landowners deal with their own household garbage onsite but the residents of Ganges, in particular, make heavy use of the garbage dump. The garbage dump is situated inland at an altitude of 500 feet and, as gulls do not frequent the dump, the ravens have a virtual monopoly, being dominant to crows. The garbage dump provides the ravens with food throughout the year except in periods of heavy snow cover, which are rare on Saltspring.

The results of questionnaires sent out to sheep producers indicated that up to 100 sheep per year were killed by ravens, but losses in 1985 were small in comparison. Improved sheep husbandry practices have helped reduce the predation problem but two other factors may also have been important. First, the total lambing season was condensed into only two to three months in 1985, with most individual flocks lambing in three to four weeks. Second, several people, especially Chris Wooldridge (SPCA officer) and Alan Best (retired curator of birds and mammals at Stanley Park Zoo), have suggested that a heavy winter mortality among the local black-tailed deer population provided extra food for scavenging birds. These people have also suggested that numbers of ravens in 1985 appeared to be smaller than in previous years.

It must be stressed that, although losses to ravens in 1985 were low, annual fluctuations will occur and sheep producers may experience more serious raven depredations in future years. Further counts of ravens would be useful in determining a pattern of annual fluctuations in numbers. In this study, it has not been possible to provide much information concerning the population dynamics of the raven on Saltspring Island. If, as I believe, the major cause of the raven problem is the high raven population rather than poor animal husbandry, then more information on ravens is necessary to deal with the problem effectively.

Recommendations

The raven population on Saltspring Island has become too high for the safety of local livestock populations. Control measures must be taken to reduce the population to an acceptable level. The lack of knowledge about the population dynamics of the raven complicates the decision as to which methods to use to reduce numbers and for how long. Unless more details of the raven's ecology on Saltspring Island are known, no one type of control measure will be effective. However, a combination of measures, over a number of years, may offset this lack of knowledge.

Although most sheep producers are taking reasonable steps to protect their animals, two possible improvements in sheep husbandry, as suggested by provincial sheep specialist Dr. Steve Mason¹, could be made. The onsite disposal of carrion (entrails of slaughtered lambs, afterbirths and carcasses of dead animals) could attract ravens. Deep burial combined with a wooden cover over the burial pit would discourage dogs and ravens from digging up carrion. In addition to this, it may be possible to protect newborn lambs by ensuring that ewes in labour are placed under cover and that they remain there until the lambs are at least two days old. Such facilities are already being provided by many of the Saltspring Island sheep producers and others may find that confining only a few animals at a time is cost-effective. However, these recommendations would have much less effect on raven predation than a reduction in raven numbers.

The Regional Problem Wildlife committee recommended in January 1985 that a legal open season on shooting ravens (on private land only) take place on Saltspring Island. Regulations to permit this open season were approved by the Ministry of Environment in June. If this method is to be effective, the shooting effort must be increased from past years (20 to 30 ravens were shot in early 1985). A concentrated effort at a place where ravens congregate in large numbers, such as the garbage dump, could help to reduce the population. Ravens are notoriously wary of guns, however, and this method may prove difficult.

Trapping ravens is possible, as proven by this year's efforts with a modified Australian crow trap. Captive ravens may be needed as decoys and the traps should be checked daily. In order to capture large numbers of ravens in a short time, several traps should be in operation at the same time. Other trapping methods such as drop-netting require considerable time and effort; cannon-netting also requires specialized training and experience. Trapping and shooting would be most effective in November and December when the population is likely to be at a peak and before the lambing season begins. However, a reduction of the Saltspring Island raven population could be temporary if other ravens readily move in from the other Gulf Islands and Vancouver Island.

¹provincial livestock nutritionist as of July 1985 - W.C.W.

As the garbage dump is a major source of food for ravens, its removal from Saltspring Island would probably result in a rapid decrease in raven numbers. By removing access to this major food source, other ravens would be deterred from migrating to Saltspring. Better management of the existing site or relocation on the island may reduce the raven population but probably only over a long period of time unless other control measures are used simultaneously. The operation of the Blackburn Road landfill site is currently being reviewed by the Waste Management Branch for reasons other than raven depredations.

Finally, it must be said that there are still too many unknowns concerning the raven population to make more specific recommendations. More information is needed on breeding numbers, breeding success, movements, mortality rates, possible seasonal changes in numbers and when and how natural mortality occurs. This would make a very suitable study for a Master's thesis, particularly as some actual breeding sites are known and a few birds have been tagged. Until this study is possible, some of the above control measures should be implemented in 1985-86 and the results carefully monitored.

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Appendix 1. Raven Attack Reporting Form

Name of farmer: _____

Address: _____

Phone no. _____

Date of attack: _____

Location: _____

No. lambs attacked: _____

No. lambs killed: _____

Details of wounds/injuries: _____

Time of day (if known): _____

If actual attack witnessed, no. ravens involved: _____

Comments on the behaviour of the ravens: _____

Total no. sheep in flock at time of attack: _____ lambs _____ ewes

Other information: _____

Appendix 2. Raven trapping information - Saltspring Island, 1985

- Jan 21 - four captive, banded ravens placed into modified Australian crow trap on Stark Road
- Jan 31 - 08:00-08:30 25-35 wild ravens flying around trap site; four captive birds in trap
- 16:30 two additional ravens in trap
- Feb 01 - eight ravens banded and wing-tagged by A. Brenchley and T. Kluge
- Feb 07 - 15:15-16:30 25+ ravens and 30-40 crows at trap site; no sign of wing-tagged birds; only three captive birds in trap
- Feb 12 - 08:10 five ravens in trap; 12+ wild birds at trap site
- Feb 14 - 08:00-08:30 six ravens in trap; some shooting near trap site
- 14:30 three ravens wing-tagged by A. Brenchley and R. Stewart
- Feb 15 - 08:30-09:30 four ravens in trap, one unbanded; no wing-tagged birds seen; ravens quite wary, probably because of shooting
- Feb 16 - six ravens in trap (M. Byron)
- Feb 18 - raccoon entered trap overnight and broke bottom wires; all but two of the ravens escaped (M. Byron)
- Feb 19 - 08:10 two banded ravens in trap; approximately 15-20 other ravens seen
- 16:45 only one raven in trap
- Feb 21 - 16:15-17:00 only one raven in trap; 12+ other ravens seen, none wing-tagged
- Feb 26 - no ravens in trap

Appendix 3. Raven Survey - Saltspring Island, January 31, 1985

Stopping Point	No. Ravens Seen	No. Ravens Heard	Total No. Crows	Time
1.	1	-	-	08:45
2.	-	-	-	08:56
3.	-	-	-	08:59
4.	-	-	-	09:06
5.	-	3	19(S)	09:14
6.	2	-	-	09:20
7.	5	3-4	-	09:27
8.	-	3-4	-	09:34
9.	-	1	-	09:40
10.	-	2	-	09:46
11.	-	-	-	09:54
12.	-	-	-	10:10
13.	-	-	-	10:17
14.	-	-	-	10:25
15.	-	-	-	10:30
16.	-	-	-	10:45
17.	-	2	-	10:53
18.	1	-	-	11:00
19.	-	-	-	11:09
20.	-	-	-	11:20
21.	-	1	-	11:27
22.	-	-	-	11:35
23.	-	-	-	11:41
24.	-	1	-	11:47
25.	-	-	-	11:55
26.	-	-	-	12:02
27.	-	-	-	12:10
28.	-	-	-	12:16
29.	-	2	7(S)	13:00
30.	-	-	27(S)	13:07
31.	-	-	1(H)	13:25
32.	-	2	-	13:30
33.	-	-	-	13:38
34.	-	1	-	13:52
35. Mt. Maxwell	2	-	-	14:03
36.	-	3-4	-	14:30
37.	-	-	-	14:40
38.	-	-	-	14:46
39.	-	4	1(H)	14:58
40. Mt. Belcher	11	2	1(H)	15:10
41. dump	20+	10	150-200	15:30
42.	-	3	1(H)	15:40
43.	-	2	-	15:46
44.	1	2	-	15:58
45.	-	2	-	16:07
46.	-	-	-	16:11
47.	1	2	-	16:17
48.	-	2	-	16:30
49.	-	-	-	16:35
50.	-	-	-	16:41
51.	-	-	-	16:50

Appendix 4. Raven Survey - Saltspring Island, February 22, 1985

Stopping Point	No. Ravens Seen	No. Ravens Heard	Total No. Crows	Time
1.	-	-	-	08:45
2.	-	-	-	08:55
3.	3	-	-	09 0
4.	-	-	1(H)	09:07
5.	-	1	-	09:13
6.	1	1	34(S)	09:22
7.	4	1	-	09:28
8.	-	-	-	09:35
9.	-	-	1(H)	09:40
10.	-	-	-	09:46
11.	-	1	-	09:57
12.	-	-	-	10:07
13.	-	-	-	10:12
14.	-	-	-	10:17
15.	-	-	-	10:21
16.	-	-	1(H)	10:35
17.	-	-	1(H)	10:40
18.	1	-	-	10:45
19.	-	2	-	10:51
20.	-	-	1(H)	11:00
21.	-	-	-	11:06
22.	-	1	-	11:15
23.	-	2	-	11:20
24.	-	-	-	11:25
25.	-	-	-	11:32
26.	-	2	-	11:39
27.	1	2	-	11:51
28.	-	-	-	12:10
29.	-	1	3(S)	12:24
30.	-	-	29(S)	12:30
31.	-	-	-	12:48
32.	-	-	-	12:56
33.	-	-	-	13:04
34.	-	2+ far away	-	13:15
35.	-	-	1(H)	13:21
36.	-	1	-	13:28
37.	-	-	-	13:38
38.	-	-	-	13:45
39.	4	-	-	13:51
40.	-	4	-	14:02
41. dump	25-30	10+	570+(S)	14:18
42.	-	4	-	14:30
43.	-	3	-	14:35
44.	2	1	-	14:42
45.	-	1	-	14:48
46.	-	-	-	14:52
47.	1	1	-	14:57
48.	-	2	-	15:05
49.	-	-	-	15:10
50.	-	1	-	15:17
51.	-	-	-	15:25

Appendix 5. Raven Survey - Saltspring Island, March 14, 1985

Stopping Point	No. Ravens Seen	No. Ravens Heard	Total No. Crows	Time
1.	-	3	-	07:08
2.	-	-	1(H)	07:17
3.	-	-	-	07:21
4.	-	-	-	07:27
5.	-	-	1(H)	07:33
6.	-	-	-	07:39
7.	-	4	-	07:46
8.	-	-	-	07:51
9.	-	-	-	07:57
10.	-	-	1(H)	08:03
11.	-	-	-	08:09
12.	-	-	3-4(H)	09:19
13.	3	-	1(S)	09:25
14.	1	-	7(S), 5(H)	09:32
15.	-	-	2(H)	09:37
16.	-	-	17(S)	09:50
17.	-	2	25(S), 4-5(H)	09:56
18.	-	1	-	10:03
19.	-	-	-	10:10
20.	-	-	3(H)	10:16
21.	1	1	1(S), 4-5(H)	10:23
22.	1	2	-	10:33
23.	-	1	-	10:40
24.	-	2	-	10:50
25.	-	1	-	10:57
26.	1	-	-	11:05
27.	-	1	-	11:10
28.	-	-	-	11:17
29.	-	3	-	11:38
30.	-	-	10(S)	11:45
31.	-	-	2(H)	11:50
32.	-	1	-	11:57
33.	-	-	-	12:04
34. Mt. Bruce	20+	2	1(S), 4-5(H)	12:17
35.	-	-	2(S)	12:23
36.	-	3	-	12:32
37.	-	-	-	12:45
38.	-	2	-	12:51
39.	1	1	-	12:59
40.	-	1	3(H)	13:08
41. dump	20+	-	60-70(S)	14:27
42.	-	7	-	14:36
43.	2	-	-	14:43
44.	4	-	-	14:50
45.	-	2	-	15:04
46.	-	-	-	15:11
47.	-	-	6(H)	15:20
48.	-	-	-	15:33
49.	-	1	-	15:40
50.	-	-	2(H)	15:45
51.	-	-	2(H)	15:48

Appendix 6. Raven Survey - Saltspring Island, April 5, 1985

Stopping Point	No. Ravens Seen	No. Ravens Heard	Total No. Crows	Time
1.	-	-	2(S)	06:50
2.	-	-	1(H)	06:55
3.	-	-	-	07:00
4.	-	-	5(S), 1(H)	07:07
5.	-	-	-	07:14
6.	-	-	-	07:20
7.	-	2	-	07:27
8.	-	1	-	07:33
9.	-	-	-	07:39
10.	-	-	-	07:45
11.	-	-	-	07:51
12.	-	1	2(H)	07:59
13.	-	-	1(H)	08:05
14.	1	1	3(H)	08:10
15.	-	-	12(S), 6(H)	08:15
16.	-	-	4(S), 2(H)	10:06
17.	-	2	6(H)	10:13
18.	-	1	-	10:18
19.	1	2	1(H)	10:25
20.	-	-	-	10:30
21.	-	-	-	10:37
22.	2	-	-	10:45
23.	-	2	-	10:52
24.	1	-	-	10:58
25.	-	1	-	11:05
26.	-	-	-	11:15
27.	-	-	2(H)	11:21
28.	-	-	2(H)	11:31
29.	-	1	-	11:45
30.	-	-	23(S)	11:50
31.	-	-	2(H)	11:56
32.	-	2	-	12:02
33.	-	-	-	12:09
34. Mt. Bruce	9	-	-	12:25
35.	1	2	-	12:33
36.	-	1	6(H)	12:42
37.	-	3	1(S)	12:51
38.	-	1	-	12:57
39.	1	2	-	13:06
40.	-	1	3(H)	13:22
41. dump	15-20	-	165(S)	13:35
42.	-	6-10	1(H)	13:57
43.	-	-	-	14:03
44.	-	1	-	14:10
45.	-	2	1(H)	14:20
46.	1	1	1(H)	14:27
47.	-	-	2(H)	14:35
48.	-	-	1(S), 1(H)	14:46
49.	-	2	-	14:52
50.	-	-	-	14:58
51.	-	-	-	15:10

Appendix 7. Raven Survey - Saltspring Island, April 24/25, 1985

Stopping Point	No. Ravens Seen	No. Ravens Heard	Total No. Crows	Time
1.	-	-	-	Apr 24 08:05
2.	-	2	-	08:10
3.	-	-	-	08:15
4.	-	1	2(H)	08:21
5.	-	1	2(H)	08:27
6.	-	-	-	08:33
7.	-	-	-	08:39
8.	-	-	-	08:45
9.	-	-	-	08:51
10.	-	-	-	08:56
11.	1	-	-	09:04
12.	-	2	2(H)	09:12
13.	-	-	1(H)	09:17
14.	-	-	2(H)	09:32
15.	-	-	5(S), 4(H)	09:43
16.	-	-	2(S)	10:07
17.	1	2	1(S)	10:13
18.	-	-	4(H)	10:20
19.	-	-	-	10:26
20.	-	-	-	10:32
21.	-	-	2(H)	10:38
22.	-	-	-	10:47
23.	-	2	-	10:55
24.	-	-	-	11:38
25.	-	-	-	11:03
26.	-	1	-	11:08
27.	-	-	-	11:19
28.	1	-	1(S), 2(H)	11:25
29.	-	-	-	11:45
30.	-	-	15(S), 1(H)	11:50
31.	-	-	6(S), 4(H)	15:06
32.	-	-	-	15:13
33.	-	-	-	15:20
34.	-	2	-	15:53
35.	-	-	-	16:00
36.	-	-	-	16:11
37.	-	4	-	Apr 25 08:40
38.	-	2	-	08:53
39.	-	2	-	09:02
40.	-	2	6(H)	09:15
41. dump	45-50	-	50+(S)	09:28
42.	-	3	-	09:44
43.	-	3	2(H)	09:50
44.	-	1	-	10:00
45.	-	1	-	10:16
46.	-	1	4(S)	10:22
47.	-	-	6(H)	10:28
48.	-	-	-	10:40
49.	-	-	-	10:45
50.	-	1	-	10:58
51.	-	-	2(H)	11:05

Appendix 8. Raven Survey - Saltspring Island, May 16, 1985

Stopping Point	No. Ravens Seen	No. Ravens Heard	Total No. Crows	Time
1.	-	-	-	06:40
2.	-	-	-	06:45
3.	-	-	-	06:51
4.	-	-	2(H)	06:57
5.	-	-	-	07:03
6.	-	-	1(H)	07:09
7.	-	-	-	07:18
8.	-	-	-	07:26
9.	-	-	2(H)	07:33
10.	-	-	-	07:39
11.	-	-	-	07:45
12.	-	-	2(H)	07:55
13.	-	-	-	08:01
14.	-	1	2(S)	08:08
15.	-	-	3(S), 10(H)	08:14
16.	-	-	6(S)	09:31
17.	-	2	1(S), 1(H)	09:38
18.	1	1	1(H)	09:45
19.	-	-	-	09:52
20.	-	-	2(H)	09:58
21.	-	1	3(H)	10:05
22.	-	-	-	10:14
23.	-	-	-	10:21
24.	-	-	-	10:29
25.	-	-	-	10:37
26.	-	-	-	10:43
27.	-	-	-	10:50
28.	-	-	2(H)	10:58
29.	-	-	-	11:16
30.	-	1	14(S), 2(H)	11:28
31.	-	-	2(S), 2(H)	11:34
32.	-	-	2(H)	11:40
33.	-	-	-	11:47
34.	-	-	-	11:59
35.	-	-	-	12:06
36.	-	-	-	12:13
37.	-	2	-	12:23
38.	-	-	-	12:30
39.	1	2	-	12:38
40.	-	1	2(H)	12:48
41. dump	30+	-	10-15(S)	13:10
42.	-	8	-	13:19
43.	-	-	-	13:26
44.	2	2	-	13:39
45.	-	-	2(H)	13:57
46.	-	-	1(H)	14:04
47.	-	-	4(S), 3(H)	14:11
48.	-	-	-	15:16
49.	-	1	1(H)	15:22
50.	-	-	-	15:28
51.	-	-	-	15:37

Appendix 9. Distribution of Ravens and Crows on Roadside Surveys 1-6

Stopping point	Ravens						Total	Crows						Total
	1	2	3	4	5	6		1	2	3	4	5	6	
1.	1	-	3	-	-	-	4	-	-	-	2	-	-	2
2.	-	-	-	-	2	-	2	-	-	1	1	-	-	2
3.	-	3	-	-	-	-	3	-	-	-	-	-	-	-
4.	-	-	-	-	1	-	1	-	1	-	6	2	2	11
5.	3	1	-	-	1	-	5	19	-	1	-	2	-	22
6.	2	2	-	-	-	-	4	-	34	-	-	-	1	35
7.	9	5	4	2	-	-	20	-	-	-	-	-	-	-
8.	4	-	-	1	-	-	5	-	-	-	-	-	-	-
9.	1	-	-	-	-	-	1	-	1	-	-	-	2	3
10.	2	-	-	-	-	-	2	-	-	1	-	-	-	1
11.	-	1	-	-	1	-	2	-	-	-	-	-	-	-
12.	-	-	-	1	2	-	3	-	-	4	2	2	2	10
13.	-	-	3	-	-	-	3	-	-	1	1	1	-	3
14.	-	-	1	2	-	1	4	-	-	12	3	2	2	19
15.	-	-	-	-	-	-	-	-	-	2	18	9	13	42
16.	-	-	-	-	-	-	-	-	1	17	6	2	6	32
17.	2	-	2	2	3	2	11	-	1	30	6	1	2	40
18.	1	1	1	1	-	2	6	-	-	-	-	4	1	5
19.	-	2	-	3	-	-	5	-	-	-	1	-	-	1
20.	-	-	-	-	-	-	-	-	1	3	-	-	2	6
21.	1	-	2	-	-	1	4	-	-	6	-	2	3	11
22.	-	1	3	2	-	-	6	-	-	-	-	-	-	-
23.	-	2	1	2	2	-	7	-	-	-	-	-	-	-
24.	1	-	2	1	-	-	4	-	-	-	-	-	-	-
25.	-	-	1	1	-	-	2	-	-	-	-	-	-	-
26.	-	2	1	-	2	-	5	-	-	-	-	-	-	-
27.	-	3	1	-	-	-	4	-	-	-	2	-	-	2
28.	-	-	-	-	1	-	1	-	-	-	2	3	2	7
29.	2	1	3	1	-	-	7	7	3	-	-	-	-	10
30.	-	-	-	-	-	1	1	27	29	10	23	16	16	121
31.	-	-	-	-	-	-	-	1	-	2	2	10	4	19
32.	2	-	1	2	-	-	5	-	-	-	-	-	2	2
33.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34.	1	2	22	9	2	-	36	-	-	6	-	-	-	6
35.	2	-	-	3	-	-	5	-	1	2	-	-	-	3
36.	4	1	3	1	-	-	9	-	-	-	6	-	-	6
37.	-	-	-	3	4	2	-	-	-	-	1	-	-	1
38.	-	-	2	1	2	-	5	-	-	-	-	-	-	-
39.	4	4	2	3	2	3	18	1	-	-	-	-	-	1
40.	13	4	1	1	2	1	22	1	-	3	3	6	2	15
42.	3	4	7	8	3	8	33	1	-	-	1	-	-	2
43.	2	3	2	-	3	-	10	-	-	-	-	2	-	2
44.	3	3	4	1	1	4	16	-	-	-	-	-	-	-
45.	2	1	2	2	1	-	8	-	-	-	1	-	2	3
46.	-	-	-	2	1	-	3	-	-	-	1	4	1	6
47.	3	2	-	-	-	-	5	-	-	6	2	6	7	21
48.	2	2	-	-	-	-	4	-	-	-	2	-	-	2
49.	-	-	1	2	-	1	4	-	-	-	-	-	1	1
50.	-	1	-	-	1	-	2	-	-	2	-	-	-	2
51.	-	-	-	-	-	-	-	-	-	2	-	2	-	4

Appendix 10. Habitat Composition Within 1/4 Mile Radius of Each Stopping Point

Stop No.	Conifer	Mixed	Broad-leaf*	Scrub	Pasture	Fresh-water	Salt-water	Residential
1.	50				40			10
2.		90						10
3.	60	30						10
4.	70	20			10			
5.	50	30			10		10	
6.	60	10			30			
7.	70	10			20			
8.	90				10			
9.	90			10				
10.	50	20	10	10		10		
11.	40	10				40		10
12.	80							20
13.	50	30		20				
14.	50	20					20	10
15.	20	10	10	10			50	
16.	30						30	40
17.		60			20		10	10
18.	20	60	10					10
19.	30	50			20			
20.	70			10	10			10
21.		40					40	20
22.	50	40			10			
23.	80	20						
24.	60	30						10
25.	40	50			10			
26.	70	10			20			
27.	80	20						
28.	60	10			20		10	
29.	40	20		20	10			10
30.	50	20					30	
31.	20	20					50	10
32.	30	40					30	
33.	60	40						
34.	10	10	30		40			10
35.	20		10		60			10
36.	60	10					20	10
37.	50	30						20
38.	70	20			10			
39.	40	10		40				10
40.	50	40	10					
41.	50	30			20			
42.	30	70						
43.	20	20		10	40			10
44.	60	20	10		10			
45.	30	60						10
46.	30	40						30
47.	40	20				30		10
48.	40	20			10			30
49.	40	40			10			10
50.		100						
51.	30	10			30			30

*including arbutus

Appendix 11. Raven Counts - Blackburn Road Garbage Dump, 1985

Date	Time	No. Ravens
Jan 21	16:00	30
Jan 22	13:30	75
Jan 24	13:30	30
Jan 31	15:30 - 15:40	30+
Feb 06	09:05 - 09:15	30+
Feb 07	12:45 - 13:30	68
Feb 12	10:30 - 11:00	64
Feb 14	13:30	37
Feb 15	12:15 - 13:05	30 - 40
Feb 19	08:05 - 09:30	50 - 60
Feb 21	10:50 - 12:15	60 - 70
Feb 22	14:15 - 14:30	36+
Feb 26	14:45 - 15:30	18
Feb 27	08:15 - 09:00	45+
Feb 28	13:30 - 14:15	75+
Mar 05	11:55 - 13:20	50 - 60
Mar 07	09:00 - 09:15	70 - 80 (40+ soaring)
Mar 08	09:00 - 09:45	60 - 70
Mar 12	10:40 - 11:40	30 - 40
Mar 13	08:15 - 08:50	35 - 40
Mar 14	14:25	20+
Mar 20	14:55 - 15:35	35 - 40
Mar 21	12:15 - 12:45	40 - 45
Mar 26	08:15 - 09:00	45 - 50
Mar 29	08:10 - 08:35	40 - 45
Apr 03	15:25	30 - 35
Apr 05	13:30 - 14:00	20+
Apr 11	07:30 - 08:00	65 - 70
Apr 16	10:30 - 11:30	25 - 30
Apr 17	12:15 - 13:00	25 - 30
Apr 24	17:20	20+ (dump on fire)
Apr 25	09:30	45 - 50 (dump on fire)
Apr 26	14:00 - 14:30	60 - 70 (dump on fire)
May 02	08:20 - 09:15	60+ (dump smouldering)
May 08	08:20 - 09:15	120+
May 15	08:10 - 08:45	25 - 30
May 16	13:10	30+

Appendix 12. Details of Three Known Nest Sites - Saltspring Island, 1985

Nest Site 1: Mt. Belcher Heights

- Apr 03 - Raven disturbed from tree below bluff.
- Apr 09 - Raven disturbed from same tree, nest structure visible.
- Apr 16 - Female incubating but disturbed on approach, no sign of young.
- Apr 18 - 09:30 - 10:10 Female on nest.
10:10 Female left and pair seen around immediate vicinity.
- Apr 24 - 12:15 - 14:15 Watched nest from top of bluff using spotting scope.
No activity around nest, believed abandoned.
- May 03 - Investigated bottom of tree. Many white droppings, no egg shells.
No sign of adults.

Nest Site 2: Opposite Entrance to Peter Arnell Park

- Mar 28 - Pair of ravens calling in agitated manner, possibly nest site nearby.
- Apr 03 - 13:00 - 15:00 One pair of birds active and calling.
- Apr 04 - Nest located in tall grand fir. Pair of ravens reluctant to leave site.
- Apr 10 - Pair of ravens still on site.
- Apr 16 - 08:30 - 10:00 Ravens calling but no activity around nest tree.
- Apr 17 - 08:20 - 09:00 No activity.
11:00 - 12:00 Nest still unattended but pair of ravens observed in vicinity.
- May 02 - 11:15 - 13:40 No sign of activity around the site but pair of ravens calling in the general area, later pair of birds seen.
Possibly re-nested not far away but could not find nest.
20:30 - 21:00 Returned at dusk to make a final check that the nest was abandoned. No roosting ravens seen or heard.

Nest Site 3: Wright Road, off Mt. Maxwell Road

- Apr 10 - Ravens active around Chris Wooldridge's house.
- Apr 15 * Approximate date of egg-laying.
- Apr 16 - Nest site located in medium-sized Douglas fir. Nest visible only from beneath. Several white droppings on ground.
- Apr 21 - Behaviour pattern changed, adults quiet and pair seen bringing food.
- Apr 24 - Shown nest, two adults disturbed. Birds extremely agitated and circling above.
- Apr 30 - Broken egg shell found beneath nest, not hatched, possibly fallen out, taken by predator or infertile.
- May 02 - Female on nest.
- May 06 * Approximate date of hatching.
- May 09 - Female still on nest, once disturbed pair of birds calling and circling overhead.
- May 15 - Nest still occupied, no sound of young as yet.
- May 23 - Nest still occupied, sounds of young heard.
- May 28 - Nest still occupied, sounds of one young heard.
- Jun 01 - Sounds of two to three young heard.
- Jun 17 - Two young seen sitting at edge of nest.
- Jun 20 * Approximate date of fledging.
- Jun 24 - Two young seen flying.
- Jul 08 - Adults and young remaining in vicinity of nest site.